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Dual isotope spin squeezing in natural mercury hot vapor for quantum enhanced magnetometry

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We investigate the use of optically-addressable nuclear spins in the fermionic isotopes of Mercury (Hg199 and Hg201) for generating macroscopically entangled spin squeezed states [1,2] in hot atomic vapors. We calculate the Wineland spin squeezing parameter [3] under the influence of different atomic loss and spin decoherence sources as well as inhomogeneous atom-light coupling within the Gaussian approximation [4] of atomic spin-f states. The novel aspects about our work are 1) investigating the simultaneous spin squeezing of two optically-addressable nuclear spins (Hg199 and Hg201) in an atomic ensemble of natural-abundance mercury, and 2) demonstrating the metrological advantage of the dual-isotope spin squeezed state in the context of quantum-enhanced magnetometry [6] and discussing possible experimental realizations.

[1] M. Kitagawa and M. Ueda, “Spin Squeezed States”, Phys. Rev. A 47, 5138,1993.
[2] A. Kuzmich et al, “Generation of Spin Squeezing via Continuous Quantum Non-demolition Measurement”, Phys. Rev. Lett. 85, 1594, 2000.
[3] D. J. Wineland et al, “Spin squeezing and reduced quantum noise in spectroscopy”, Phys. Rev. A 46, R6797(R), 1992.
[4] L. B. Madsen and K. Mølmer, “Spin squeezing and precision probing with light and samples of atoms in the Gaussian description”, Phys. Rev. A 70, 052324, 2004.
[5] G. Colangelo et al, “Quantum atom–light interfaces in the Gaussian description for spin-1 systems”, New J. Phys. 15 103007, 2013.
[6] R. J. Sewell et al, “Magnetic Sensitivity Beyond the Projection Noise Limit by Spin Squeezing”, Phys. Rev. Lett. 109 253605, 2012.

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